Technical Report EL-97-20
September 1997

US Army Corps
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Station

An Analysis of Freshwater Mussels (Unionidae) in Five Tributaries of the Big Sunflower River Drainage, 1996

by Andrew C. Miller, Barry S. Payne

Prepared for U.S. Army Engineer District, Vicksburg

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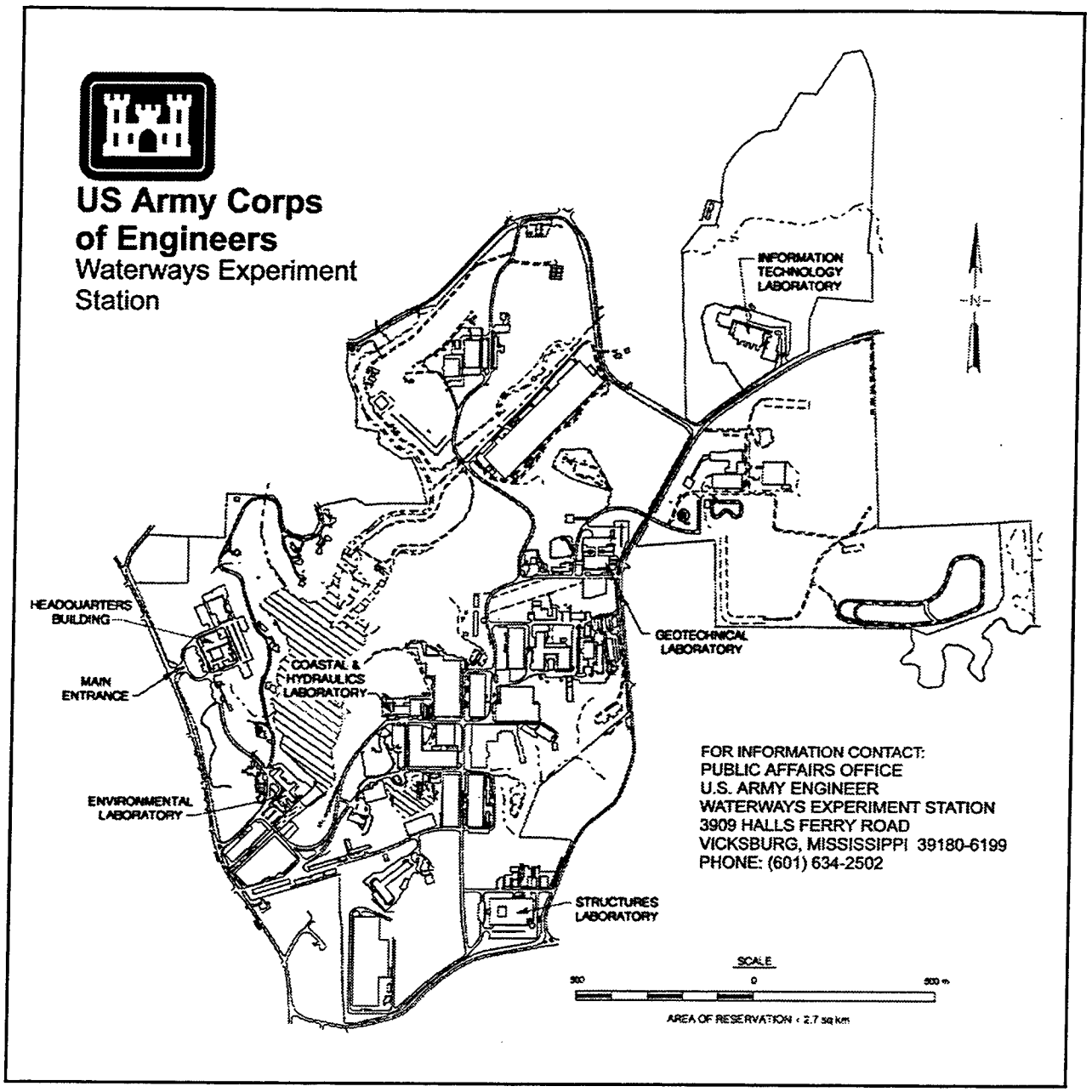

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Preface

A survey to assess community characteristics, density, population demography of dominant species, and the presence of endangered species of mussels (Family: Unionidae) was conducted in five tributaries of the Big Sunflower River Drainage, Mississippi. Work was done for the U.S. Army Engineer District, Vicksburg, and results will be used to determine environmental effects of maintenance dredging proposed for selected reaches of these tributaries. Studies were conducted by the U.S. Army Engineer Waterways Experiment Station (WES) in the summer of 1996.

This report was prepared by Drs. Andrew C. Miller and Barry S. Payne, Aquatic Ecology Branch (AEB), Ecological Research Division (ERD), Environmental Laboratory (EL), WES.

Assistance in the field was provided by Messrs. David Morrow and Nathan Woods, WES. Mr. Marvin Cannon, U.S. Army Engineer District, Vicksburg, assisted with the design of the survey and provided maps and other background information. Figures and tables were prepared by Ms. Monica Sanders, Jackson State University.

During the conduct of this study, Dr. John Harrison was Director, EL; Dr. Conrad J. Kirby was Chief, ERD; and Dr. Alfred F. Cofrancesco, was Chief, AEB.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
degrees (angle)	0.01745329	radians
feet	0.3048	meters
miles (U.S. statute)	1.609347	kilometers
tons (2,000 pounds, mass)	907.1847	kilograms

1 Introduction

Background

The U.S. Army Engineer District, Vicksburg, is planning to dredge selected reaches of five tributaries in the Big Sunflower River Drainage in Bolivar, Leflore, and Sunflower counties, northwestern Mississippi (Figure 1). Work will be accomplished by selective dredging with a clamshell dredge. The five tributaries are Jones Bayou, Marsh Bayou, Porter Bayou, Snake Bayou, and Turkey Bayou.

Environmental studies are required in part because results of past surveys (Miller, Payne, and Hartfield 1992; Miller and Payne 1995) indicated that valuable stocks of freshwater mussels (Family: Unionidae) inhabit portions of the Big Sunflower River. District personnel and others considered it likely that valuable mussel stocks could be in the tributaries that will be dredged.

Before the use of plastics, freshwater mussel shells were used to manufacture pearl buttons (Coker 1919). Today, shells are used to culture pearls; they are cut into cubes, ground into spheres, and inserted into oysters. In the early 1990s, the increased demand of 3-5 previous years pushed the price of shells to about $6 per pound on the Japanese market (Williams et al. 1993). The preferred shell for pearl making is thick, white, and free of blemishes. Because they are usually abundant and have thick shells, the threeridge (*Amblema plicata plicata*) and washboard (*Megalonaias nervosa*) are in high demand by the industry. In 1991, the total tonnage of shells exported to Japan was 9,000 short tons,[1] but within several years demand declined to about 4,500 short tons (Baker, as cited by Williams et al. 1992). Recent concern over the spread of the exotic zebra mussel (*Dreissena polymorpha*) and its effects on native mussels could increase the demand and price for high-quality shell.

Freshwater mussels in most Mississippi streams tend to be scattered and not found in discrete beds. Often they are locally abundant immediately upriver or downriver of a low-water dam or weir. Most surveys in Mississippi have been qualitative, with investigators collecting live mussels or shells by hand. Qualitative data

[1] A table of factors for converting non-SI units of measurement to SI units is presented on page vi.

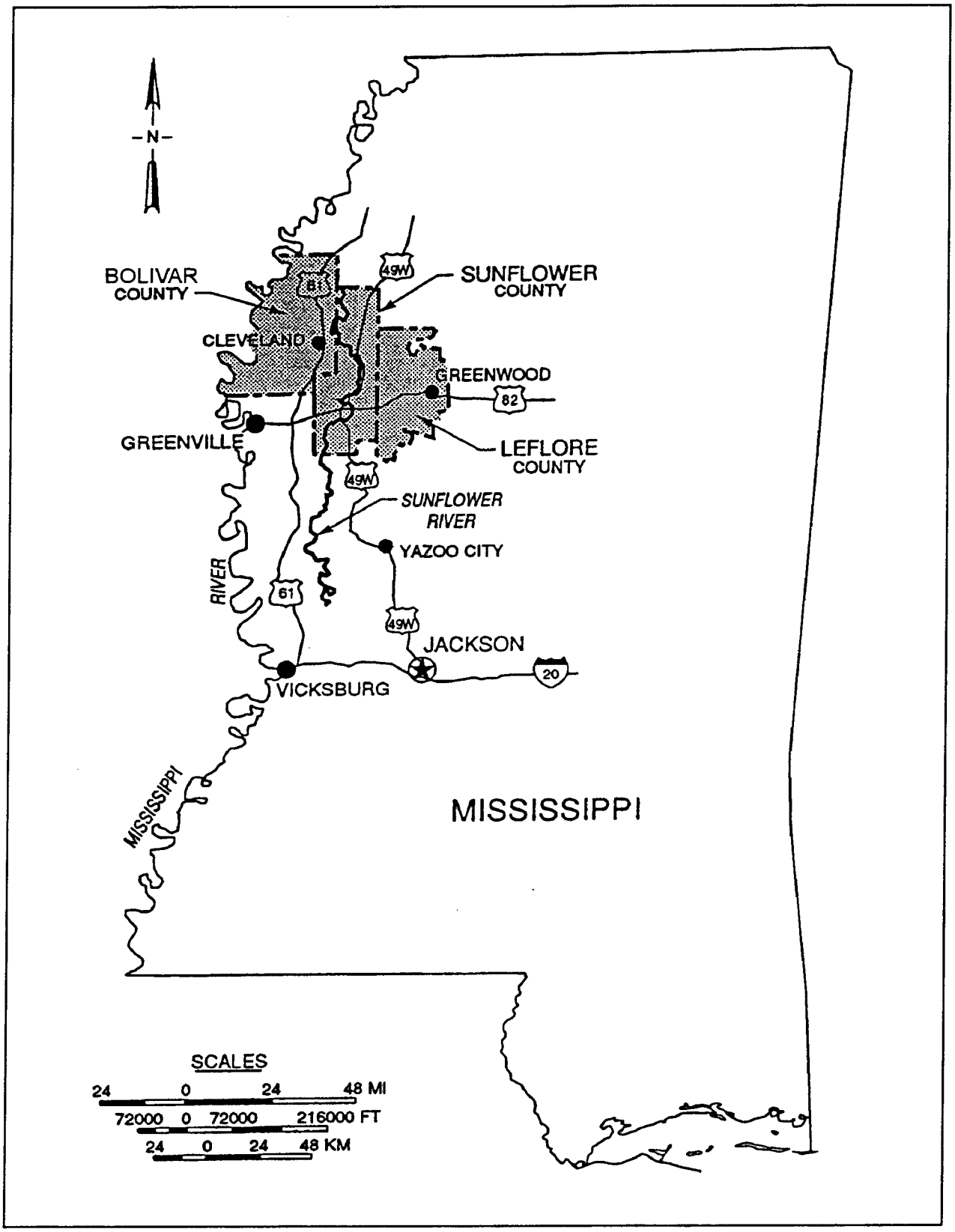

Figure 1. Map of study area showing five tributary streams

on Mississippi bivalves have been obtained by Hinkley (1906), Frierson (1911), Isom and Yokley (1968), Grantham (1969), Stern (1976), Yokley (1979), Cooper and Johnson (1980), Hartfield and Rummel (1985), Hartfield and Ebert (1986), and Bogan, Hartfield, and Bogan (1987). Personnel of the U.S. Army Engineer Waterways Experiment Station surveyed the nearby Big Sunflower River for mussels (Miller, Payne, and Hartfield 1992; Miller and Payne 1995). In 1993, they found four distinctive beds with moderate- to high-density populations (Miller and Payne 1995). However, low-density populations of commercial shells were found along virtually the entire river. There are no published records on mussels from any of the five tributaries where channel maintenance has been proposed.

Purpose and Scope

The purpose of this report is to present information on the location, species composition, density, and economic value of mussels in selected reaches of five tributaries in the Big Sunflower River Drainage, northwestern Mississippi. Information will be used by District personnel and others to evaluate the impacts of selective dredging.

2 Study Area and Methods

Study Area

The study area includes five tributaries in the Big Sunflower River Drainage (Jones Bayou, Marsh Bayou, Porter Bayou, Snake Creek, and Turkey Bayou) in Bolivar, Leflore, and Sunflower counties (Figure 1). These tributaries are in the Delta in the northwestern section of Mississippi. All are low gradient, and substratum consists of sand and silt with little or no gravel. None have extensive pool-riffle sequences characteristic of rivers in high-gradient terrain. Banks are steep, often poorly vegetated, and subject to erosion. Typically, there are few aquatic plants present, although in some reaches there is considerable woody debris. Water velocity in the summer is usually less than 50 cm/sec, although during high discharge velocities between 0.5 and 1 m are common.

At each of the five tributaries, mussels were collected using quantitative and qualitative methods (Table 1). Following is a brief description of conditions in each tributary.

Jones Bayou

Jones Bayou starts in northwestern Sunflower County and enters the Big Sunflower River approximately 3 miles north of Sunflower, MS. Thirteen sites were surveyed using qualitative methods (Table 1, Figure 2). A total of thirty 0.25-m^2 quadrat samples were taken from 5 of 13 sites.

The upstream reaches of Jones Bayou were notably different from reaches near the mouth. In the upstream reaches, velocity was between 15 and 25 cm/sec, and depth was between 0.5 and 1 m. In the downstream reaches, substratum consisted of hard clay, and water depth was between 10 and 80 cm. Near the confluence with the Big Sunflower River, substratum consisted of firmly packed gravel and clay that was not suitable for mussels. In the project area, Jones Bayou was 4-5 m wide. In the lower reach, banks consisted of hard clay, were 25 cm high, and supported little terrestrial vegetation. In the upper reaches, banks were also approximately 25 cm high and were well vegetated.

Table 1
Study Sites Along Five Tributaries in Big Sunflower River Drainage, Mississippi, 1996

Site Number	Study Area	Type of Sample		
		Qualitative	Quantitative	
		Surveyed	Surveyed	No. of Quadrats
16	Jones Bayou	x		
17	Jones Bayou	x		
19	Jones Bayou	x		
18	Jones Bayou	x		
28	Jones Bayou	x		
27	Jones Bayou	x		
29	Jones Bayou	x	x	6
31	Jones Bayou	x	x	6
30	Jones Bayou	x	x	6
33	Jones Bayou	x	x	6
32	Jones Bayou	x	x	6
40	Marsh Bayou	x	x	6
41	Marsh Bayou	x	x	6
42	Marsh Bayou	x		
43	Marsh Bayou	x		
44	Marsh Bayou	x		
45	Marsh Bayou	x		
9	Porter Bayou	x	x	6
8	Porter Bayou	x	x	6
10	Porter Bayou	x		
11a	Porter Bayou	x		
11b	Porter Bayou	x		
14	Porter Bayou	x		
15	Porter Bayou	x		
12	Porter Bayou	x		
13	Porter Bayou	x		
46	Snake Creek	x		
2	Snake Creek	x	x	6
1	Snake Creek	x	x	7
4	Snake Creek	x	x	6
3	Snake Creek	x	x	7
7	Snake Creek	x		
6	Snake Creek	x		
21	Snake Creek	x		

(Continued)

Table 1 (Concluded)

Site Number	Study Area	Type of Sample		
		Qualitative	Quantitative	
		Surveyed	Surveyed	No. of Quadrats
20	Snake Creek	x		
22	Snake Creek	x		
5a	Snake Creek	x		
5a	Snake Creek	x		
24	Snake Creek	x	x	6
23	Snake Creek	x	x	6
26	Snake Creek	x	x	6
25	Snake Creek	x	x	6
37	Turkey Bayou	x		
36	Turkey Bayou	x	x	6
39	Turkey Bayou	x	x	6
38	Turkey Bayou	x	x	6
35	Turkey Bayou	x		
34	Turkey Bayou	x		
Total		48	20	122

Marsh Bayou

Marsh Bayou originates in northeastern Leflore County. It flows west and south and enters the Quiver River west of Schlater, MS. Six sites were surveyed using qualitative methods (Table 1, Figure 3). Two of these sites were sampled using quantitative methods; a total of 12 samples were collected.

Substratum in Marsh Bayou consisted of fine-grained sediments. Most banks were approximately 30 cm high, composed of clay and without vegetation. Marsh Bayou was about 3-4 m wide, and velocity was 0.0 to 15 cm/sec. Water depths were between 0.75 and 1 m.

Porter Bayou

Porter Bayou originates in western Bolivar County, flows east and south, and enters the Big Sunflower River approximately half way between the town of Sunflower and the mouth of the Quiver River. Nine sites were sampled using qualitative methods (Table 1, Figure 4). Quantitative samples were taken at two of these sites.

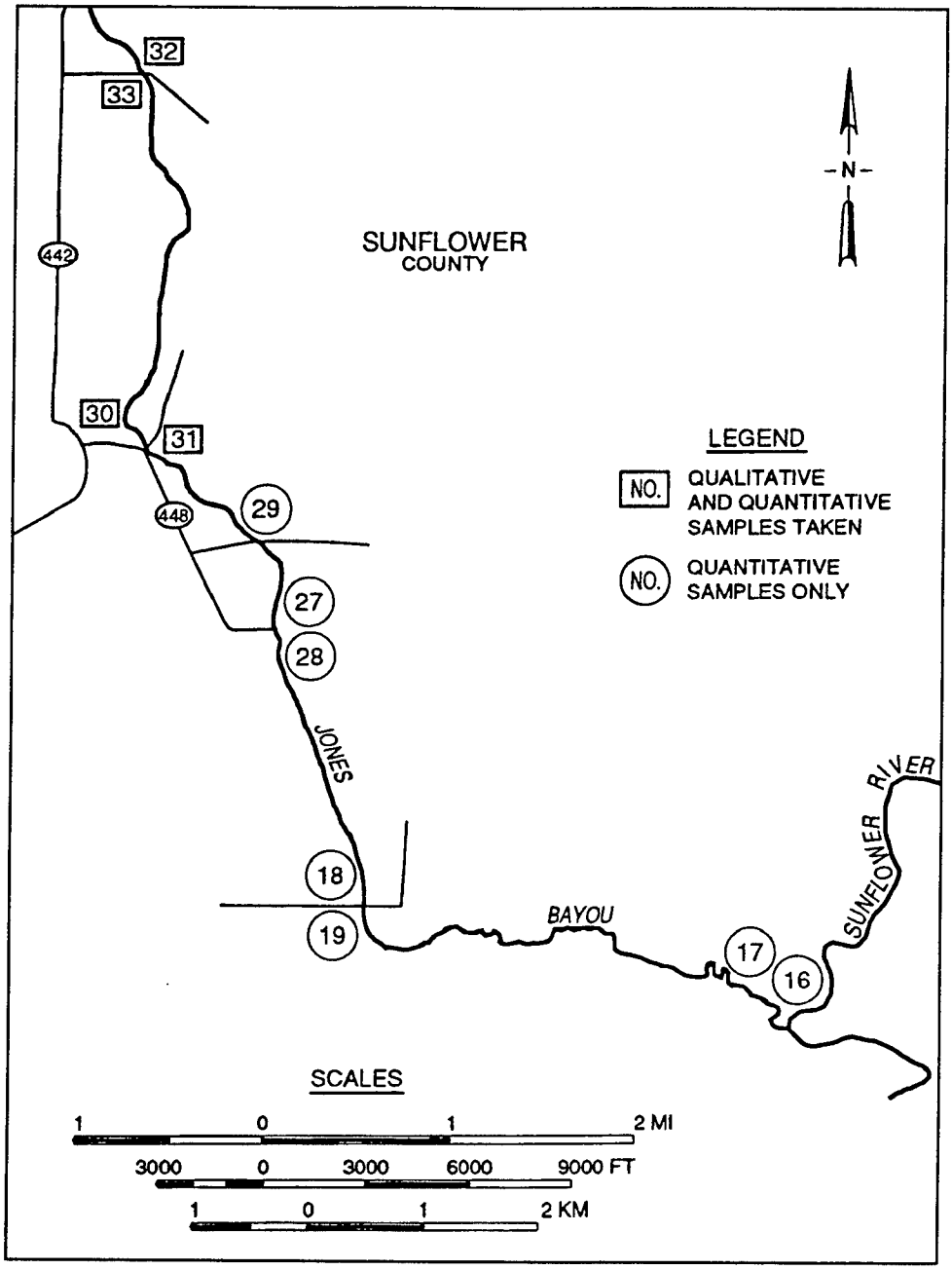

Figure 2. Sample sites along Jones Bayou in Big Sunflower Drainage, Mississippi, 1996

Porter Bayou was characterized by clay banks and long channels blanketed with fine-grained sediments. Water velocity was approximately 6-20 cm/sec and depths approximately 0.75-1 m. Width was between 3 and 4 m, and banks were 0.75-1.0 m high and without vegetation.

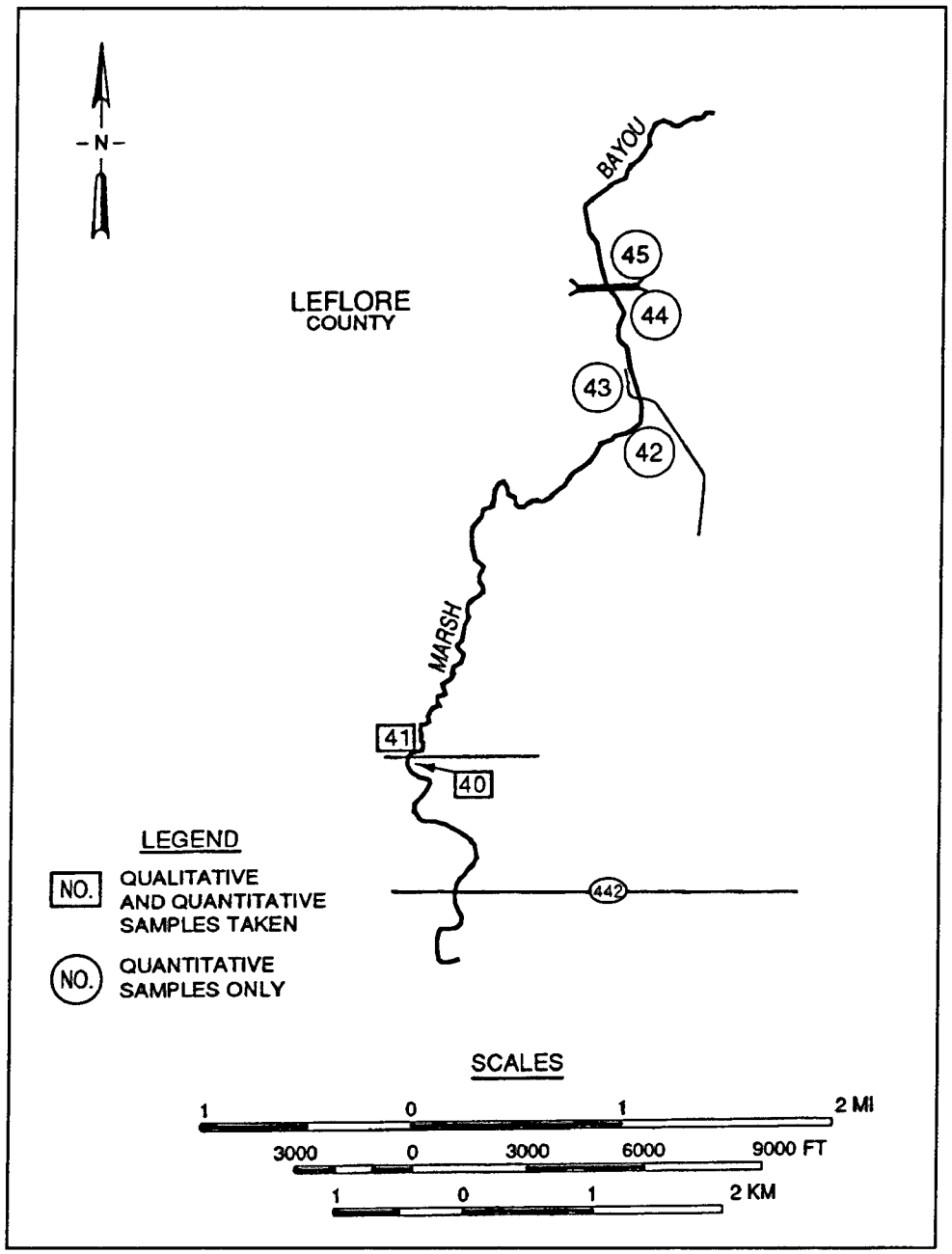

Figure 3. Sample sites along Marsh Bayou in Big Sunflower Drainage, Mississippi, 1996

Snake Creek

Snake Creek originates in northern Bolivar County and flows west where it joins Bogue Phalia south of Pace, MS. Sixteen sites were surveyed using qualitative methods (Table 1, Figure 5). Either six or seven quantitative samples were taken from eight of these sites.

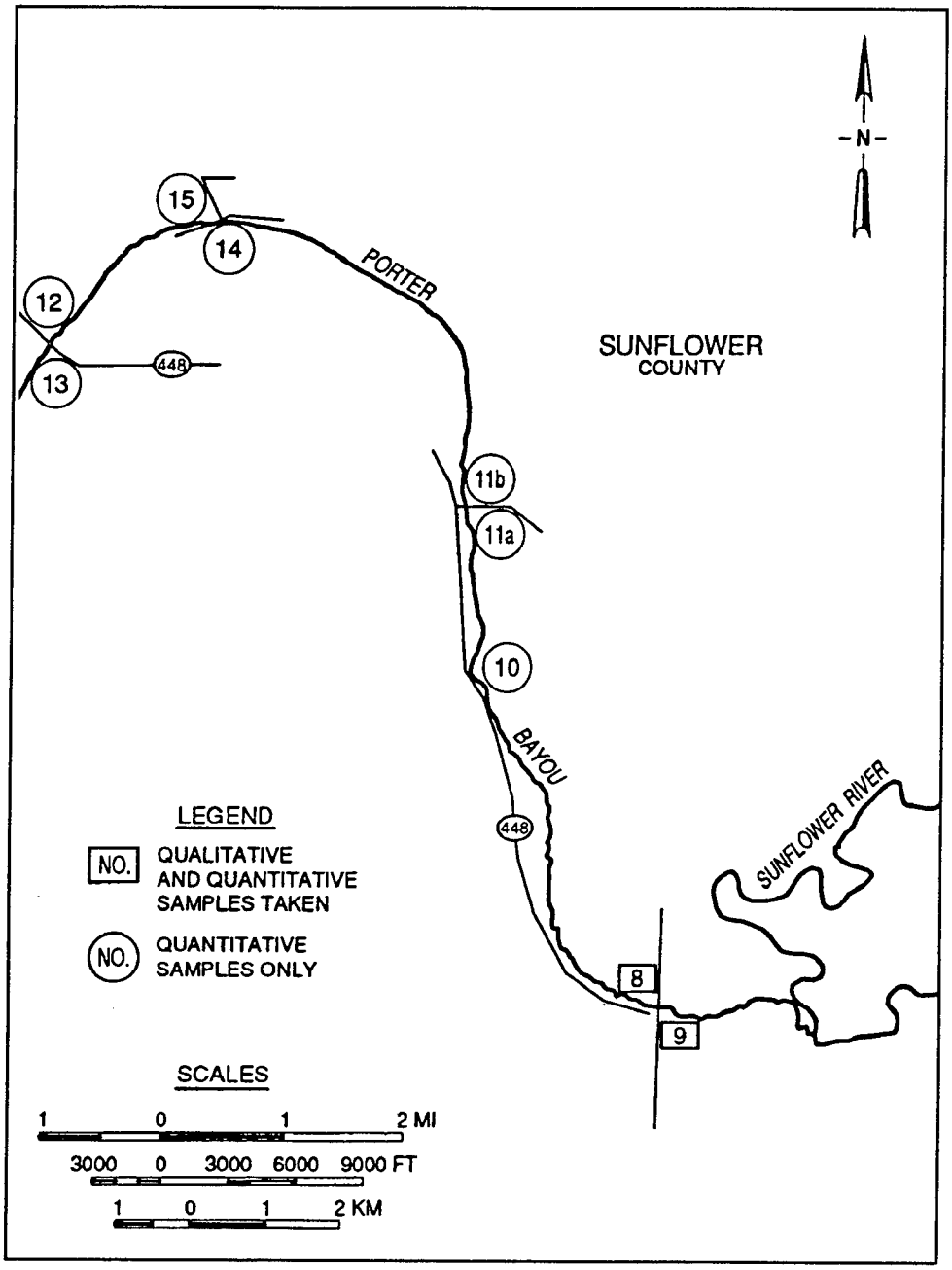

Figure 4. Sample sites along Porter Bayou in Big Sunflower Drainage, Mississippi, 1996

Snake Creek was slightly deeper and wider than the other four tributaries. At most sites, depth was 1-1.5 m, width was 6-8 m, and substratum consisted of fine-grained sediments. Banks were sloped approximately 45 deg, between 2 and 3 m high, and well vegetated. Water velocity was between 0 and 15 cm/sec at all sites.

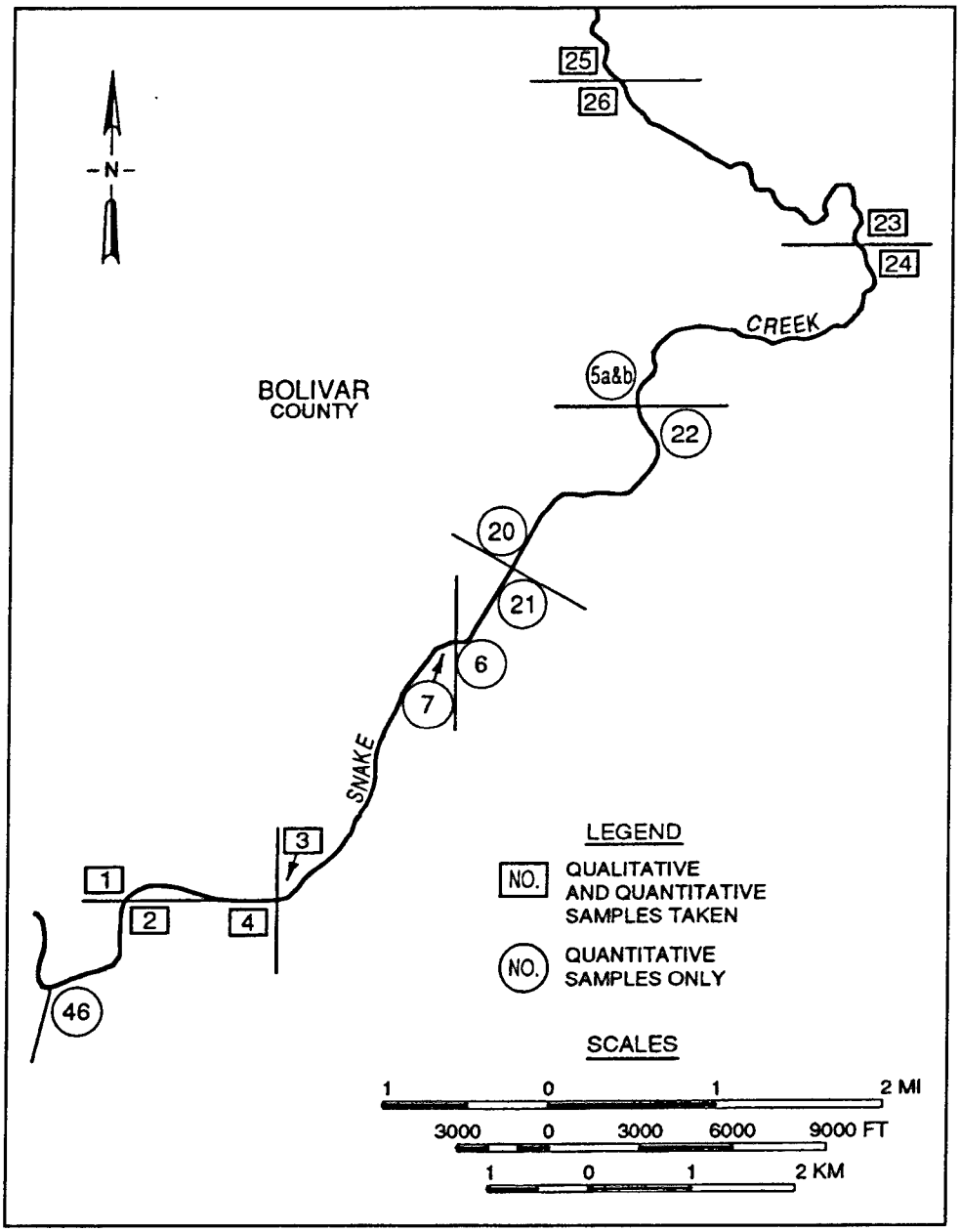

Figure 5. Sample sites along Snake Creek in Big Sunflower Drainage, Mississippi, 1996

Turkey Bayou

Turkey Bayou is in Leflore County and enters the Quiver River west of Itta Bena, MS. Five sites were surveyed using qualitative methods (Table 1, Figure 6). Six quantitative samples were taken from three of these sites.

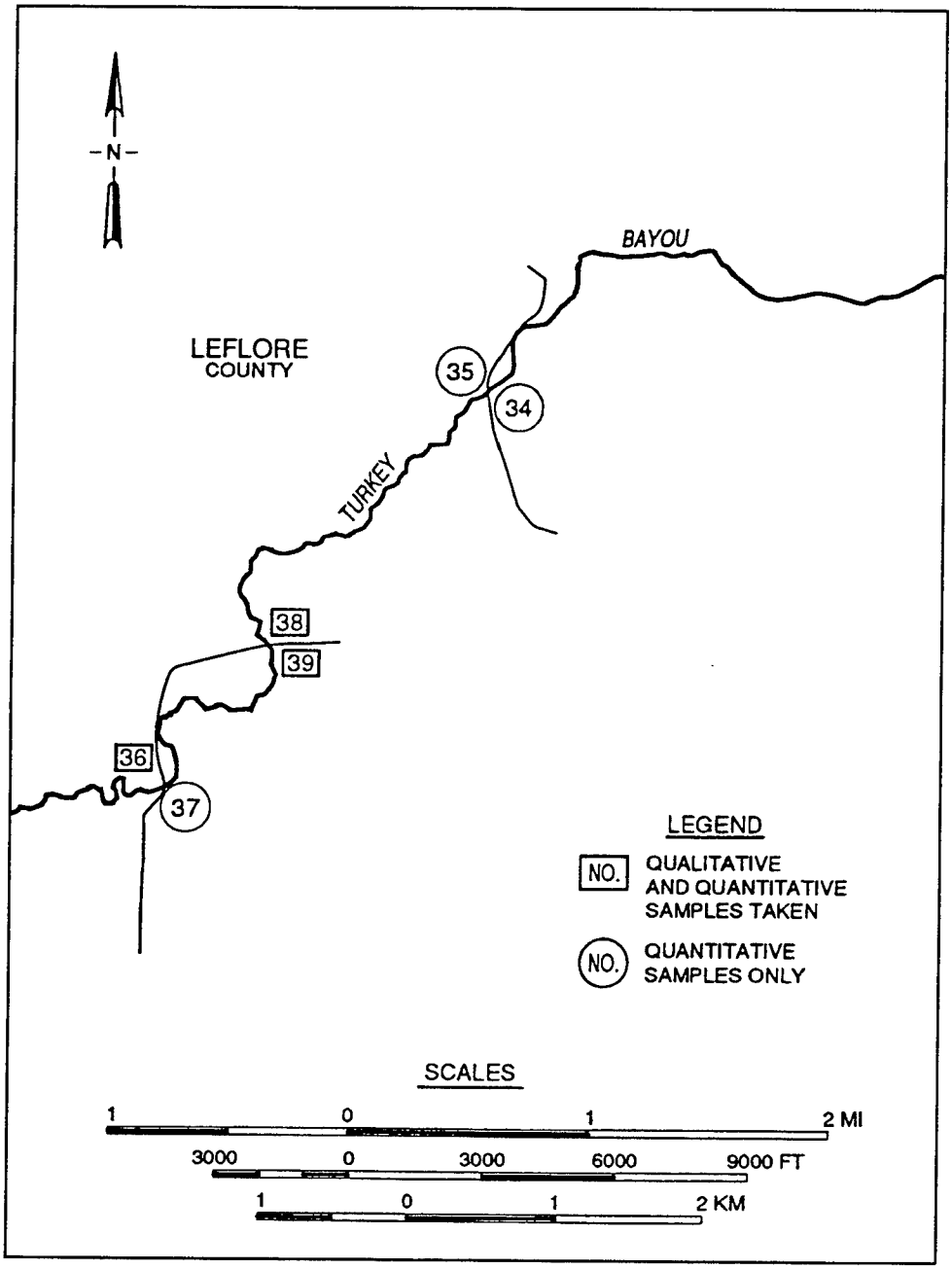

Figure 6. Sample sites along Turkey Bayou in Big Sunflower Drainage, Mississippi, 1996

Turkey Bayou was atypical of the tributaries in that it had comparatively high water velocity (25-50 cm/sec) in most reaches. Water depth was 1-2 m, and substratum consisted of sand and clay in high-velocity reaches. Throughout most of the bayou, the clay/sand banks were steep, eroding, and approximately 1-2 m high. Near the mouth, banks were steep and well vegetated.

Methods

A preliminary reconnaissance of the study area was made prior to initiating intensive sampling. This was accomplished by visiting at least one site on each tributary. A preliminary search for mussels was made to provide estimates of abundance and species composition. Notes were made on substratum conditions, water depth and velocity, and presence of shells. Along each tributary, sites were chosen for detailed qualitative and quantitative sampling.

Qualitative samples were obtained by having two or three individuals each collect at a site for specific periods of time, usually 15 min. Searches were made by feel since water visibility was usually less than several centimeters. Collectors ran their hands over the top few centimeters of substratum and retrieved all mussels encountered by touch. All mussels were brought to the surface, counted, and identified. Data were recorded on standard data sheets and returned to the laboratory for analysis and plotting. Mussels not needed for voucher were returned to the river. Sampling methods are based on techniques described in Isom and Gooch (1986); Kovalak, Dennis, and Bates (1986); Miller and Payne (1988); and Miller et al. (1993). Taxonomy is consistent with Williams et al. (1992). Qualitative samples were obtained at 48 sites on five tributaries. A total of 1,350 min (22.5 hr) were expended searching for mussels using qualitative methods (Table 2).

In addition to the qualitative work, quantitative samples were obtained at two or more sites along each tributary. Sites that appeared to have the largest number of mussels present, based on qualitative collections, were chosen. Quantitative samples were taken by haphazardly placing a 0.25-m^2 aluminum quadrat on the bottom. The collector moved his hand through the top few centimeters of the substratum in the quadrat and retrieved all live mussels and shells. Although this method is unsuitable in coarse-grained substratum, large- and small-sized mussels in fine-grained sediments can be easily collected in an unbiased manner.

Mussels from each quadrat were returned to the laboratory. Each bivalve was identified and total shell length (SL) measured to the nearest 0.1 mm with digital calipers.

Species diversity was determined with the following formula:

$$H' = - p_j log\, p_j$$

where p_j is the proportion of the population that is of the j^{th} species (Shannon and Weaver 1949). Evenness was calculated with the modified Hill's ratio (Ludwig and Reynolds 1988). All calculations were done with programs written in BASIC or SAS (Statistical Analytical System) on a personal computer. Discussion of statistical procedures that were used can be found in Green (1979) and Hurlbert (1984).

Table 2
Summary of Results of Qualitative Sampling for Mussels Along Five Tributaries in Big Sunflower River Drainage, 1996

Species	Jones Bayou	Marsh Bayou	Porter Bayou	Snake Creek	Turkey Bayou	Percent Abund	Percent Occurrence	
							All Sites	All Tributaries
A. p. plicata	135		60	1,425	8	90.55	60.4	80.00
P. dombeyanus			3	71	2	4.23	27.1	60.00
P. grandis		1	13	3		0.95	14.6	60.00
P. purpuratus			4	10	1	0.83	16.7	60.00
L. teres			1	13		0.78	22.9	40.00
Q. p. pustulosa	7		2	1		0.56	8.3	60.00
L. fragilis			2	6	3	0.61	2.1	60.00
L. subrostrata		6				0.33	10.4	20.00
F. flava				4		0.22	2.1	20.00
G. rotundata			3			0.17	2.1	20.00
A. suborbiculata			2			0.11	4.2	20.00
L. straminea				2		0.11	2.1	20.00
A. confragosus				2		0.11	8.3	20.00
Q. nodulata			2			0.11	2.1	20.00
U. tetralasmus			1			0.06	2.1	20.00
U. declivus	1					0.06	2.1	20.00
Q. quadrula		1				0.06	2.1	20.00
P. alatus			1			0.06	2.1	20.00
T. truncata	1					0.06	2.1	20.00
A. ligamentina				1		0.06	2.1	20.00
Total mussels	144	8	94	1,538	14	1,798		
Total species	4	3	12	11	4	20		
Percent of all tributaries	8.01	0.44	5.23	85.54	0.78			
Total time, min	330	150	270	465	135			
Mussels/min	0.44	0.05	0.35	3.31	0.10			

3 Bivalve Community

Overall Characteristics of Mussel Resource

Community composition

A total of 1,798 live mussels were collected at 48 sites along the five tributaries using qualitative methods (Table 2). Twenty species were collected, and 1,350 min were spent searching. The fauna was heavily dominated by *A. p. plicata*, which represented 91 percent of the total collection. The bankclimber (*Plectomerus dombeyanus*) comprised 4 percent of the mussels and was second in abundance. Each of the remaining 18 species comprised less than 1 percent of the fauna. Because of the strong dominance of *A. p. plicata*, overall species diversity and evenness, 0.54 and 0.33, were extremely low. No unusual, very uncommon, threatened, or endangered species were collected. The nonindigenous *Corbicula fluminea* were collected, although no zebra mussels (*Dreissena polymorpha*) were seen. All native mussels were characteristic of low-gradient streams or bayous with high levels of sedimentation. The extremely low species diversity, as well as comparative few numbers of riffle species (*Pleurobema* spp. and *Fusconaia* spp.), indicates that the fauna is being stressed, probably by high temperatures, low dissolved oxygen, and low current velocity.

Total density

At four of the five tributaries surveyed, overall mussel densities were extremely low (Table 3). In Marsh Bayou, Porter Bayou, and Turkey Bayou, mean density was either 0 or less than 1.0. In Jones Bayou, total mean density was estimated at 4.8 individuals/square meter. The highest densities found in the project area were recorded from Snake Creek. Overall mean density (N = 50) was 46.9 individuals/square meter, and the maximum number of mussels found in a single 0.25-m^2 quadrat was 75 (equal to a density of 300 individuals/square meter).

Amblema p. plicata dominated the quantitative collection, making up slightly more than 90 percent of all individuals collected (Table 4). The second most abundant species was *Plectomerus dombeyanus* (7 percent), and the remaining seven

Table 3
Summary Statistics for Mussels Collected Using 0.25-m^2 Quadrats Along Five Tributaries of Big Sunflower Drainage, Mississippi, 1996

Water Body	N	Mean	Minimum	Maximum	SE
Jones Bayou	30	4.80	0	28	1.24
Marsh Bayou	12	0.00	0	0	0.00
Porter Bayou	12	0.67	0	4	0.45
Snake Creek	50	46.88	0	300	11.56
Turkey Bayou	18	0.67	0	4	0.36

Table 4
Number of Mussels Collected Using Quantitative Sampling Methods (0.25-m^2 quadrats) at Five Tributaries in Big Sunflower River Drainage, 1996

Species	Water Body					Percent Abundance
	Jones	Marsh	Porter	Snake	Turkey	
A. p. plicata	31		2	536	3	91.23
P. dombeyanus				47		7.50
Q. pustulosa	1			1		0.32
Q. quadrula	1					0.16
L. fragilis	1					0.16
L. teres				1		0.16
Q. nodulata	1					0.16
T. truncata				1		0.16
P. grandis	1					0.16
Total mussels	36	0	2	586	3	627
Total species	6	0	1	5	1	9
Species diversity	0.36					
Evenness	0.45					

species each made up less than 1 percent of the fauna. Over 40 percent of all quadrats contained at least one *A. p. plicata* (Table 5). *Plectomerus dombeyanus* was found in 11 percent, and *Quadrula p. pustulosa* was found in 1.7 percent of the quadrats. The remaining seven species were very uncommon and were found in less than 1 percent of the quadrats collected.

A total of 122 quadrat samples were collected (Table 1); live mussels were only found in 27 (Figure 7a). Mussel distribution was very patchy, and only a few quadrats had more than 50 mussels present. The majority of the quadrats had no species present, and only three species were found in a single quadrat (Figure 7b,c).

Table 5
Frequency of Occurrence of Mussels Collected Using Quantitative Sampling Methods (0.25-m^2 Quadrats) at Five Tributaries in Big Sunflower River Drainage, 1996

Species	Water Body					Percent Occurrence
	Jones	Marsh	Porter	Snake	Turkey	
A. p. plicata	14		2	28	3	40.17
P. dombeyanus				13		11.11
Q. pustulosa	1			1		1.71
Q. quadrula	1					0.85
L. fragilis	1					0.85
L. teres				1		0.85
Q. nodulata	1					0.85
T. truncata				1		0.85
P. grandis	1					0.85
Total samples	30	12	12	50	18	122

Mussel Fauna in Each Tributary Stream

Jones Bayou

Virtually no mussels were taken at 9 of the 11 sites sampled using qualitative methods in Jones Bayou (Table A1). However, moderately dense mussel populations were found at two sites located farthest upstream, Numbers 33 and 32 (Figure 2). Overall collecting rate was 2.2 and 2.5 mussels collected per minute at Sites 33 and 32, respectively. *Amblema p. plicata* dominated at both sites; a single individual of *Truncilla truncata* was found at Site 33 and seven *Quadrula p. pustulosa* were collected at Site 32. Approximately 8 percent of all mussels collected in the project area were taken from Jones Bayou (Table 2).

Marsh bayou

Live mussels were collected at only one (Site 42, see Figure 3) of the six sites sampled on Marsh Bayou using qualitative methods (Table A2). Three species and eight individuals were found; collecting rate was low, 0.27 individuals/minute. Mussels found along Marsh Bayou represented only 0.4 percent of the total collection (Table 2).

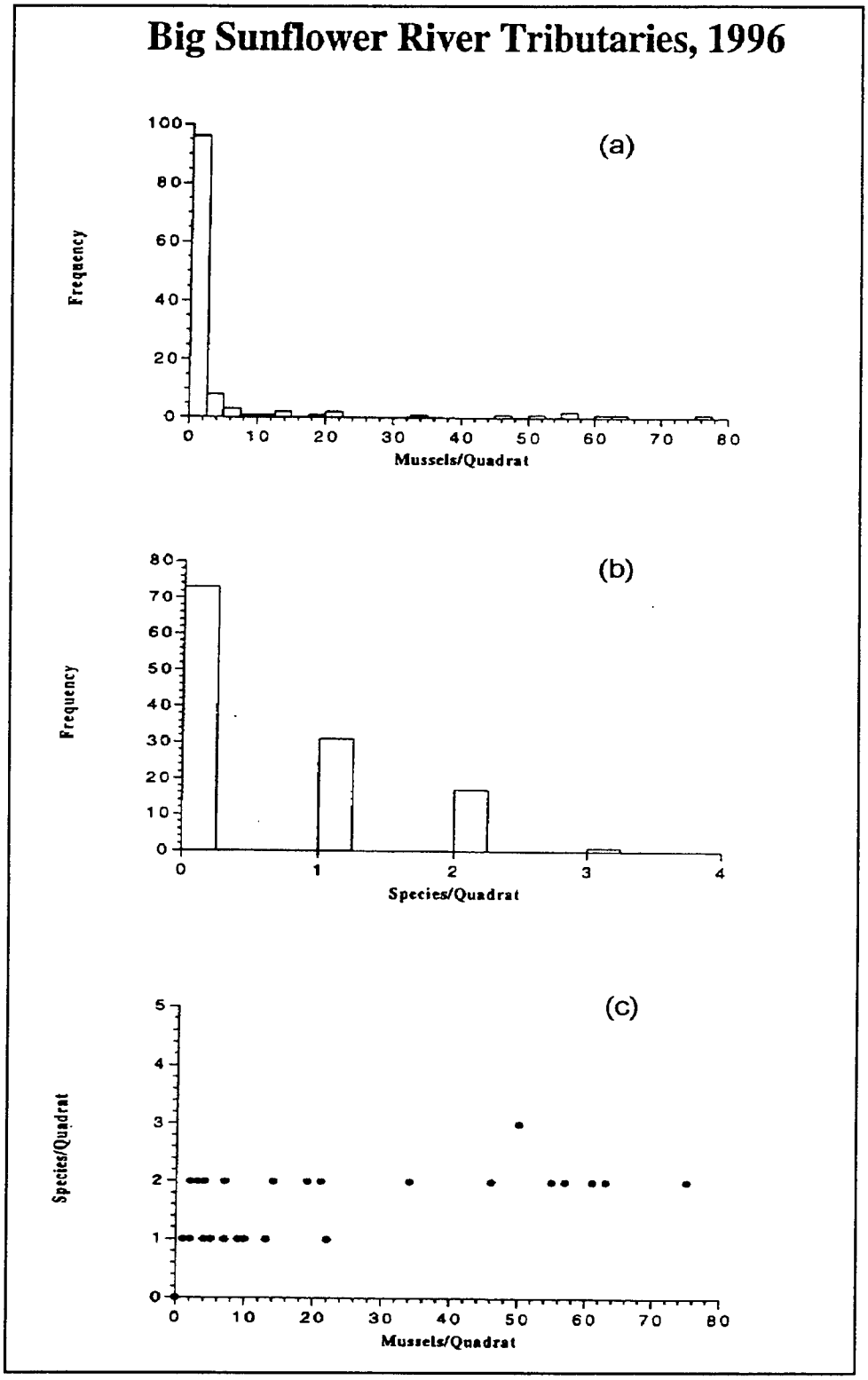

Figure 7. Relationship between number of mussels and number of species per quadrat in project area

Porter Bayou

At least some live mussels were taken at each of the nine sites surveyed qualitatively along Porter Bayou (Table A3, Figure 4). However, at five of these sites, less than six live mussels were collected. Collecting rate ranged from a low of 0.03 mussels/minute at two sites to a high of 0.90 mussels/minute at Site 9, the most downriver site. A total of 94 mussels were taken, which represented 5.2 percent of the total collection (Table 2).

Snake Creek

Eleven species and over 1,500 mussels were taken along Snake Creek (Table A4). Mussels were found at each of the six sites sampled, and collection rate ranged from 0.47 at Site 20 to a high of 9.0 individuals/minute at Site 3 (Figure 5). More than 85 percent of all mussels collected using qualitative methods along the five tributaries were found in Snake Creek (Table 2).

Turkey Bayou

Live mussels were found at three of the six sites sampled qualitatively along Turkey Bayou (Table A5). Collecting rate was low and ranged from 0.13 at two sites to 0.3 individuals/minute at one site. Four species and 14 individuals were collected, which represented 0.8 percent of the total qualitative collection from all tributaries (Table 2).

Size Demography of Dominant Populations

Only *Amblema p. plicata* and *Plectomerus dombeyanus* were collected in sufficient numbers to analyze population size structure (Figure 8). Both populations were characterized by the total absence of recent recruits. The *Amblema p. plicata* population included no mussels smaller than 65 mm long. No *P. dombeyanus* were less than 80 mm long. *Amblema p. plicata* taken from the Big Sunflower River tributaries ranged from 65 to 125 mm long, and modal length was approximately 85 mm. *Plectomerus dombeyanus* ranged from 80 to 120 mm long, and modal length was approximately 100 mm.

Economic Value of Mussels in Project Area

The commercial shell industry typically purchases only thick-shelled species to make cultured pearls. In addition to having a thick shell, nacre must be white and free of blemishes. Although many species are potentially marketable (i.e., *Quadrula* spp. and *Fusconaia* spp.), the threeridge (*A. p. plicata*) and washboard (*M. nervosa*) comprise the majority of the market. In tributaries of the Big Sunflower River drainage, the only species with enough numbers present to collect

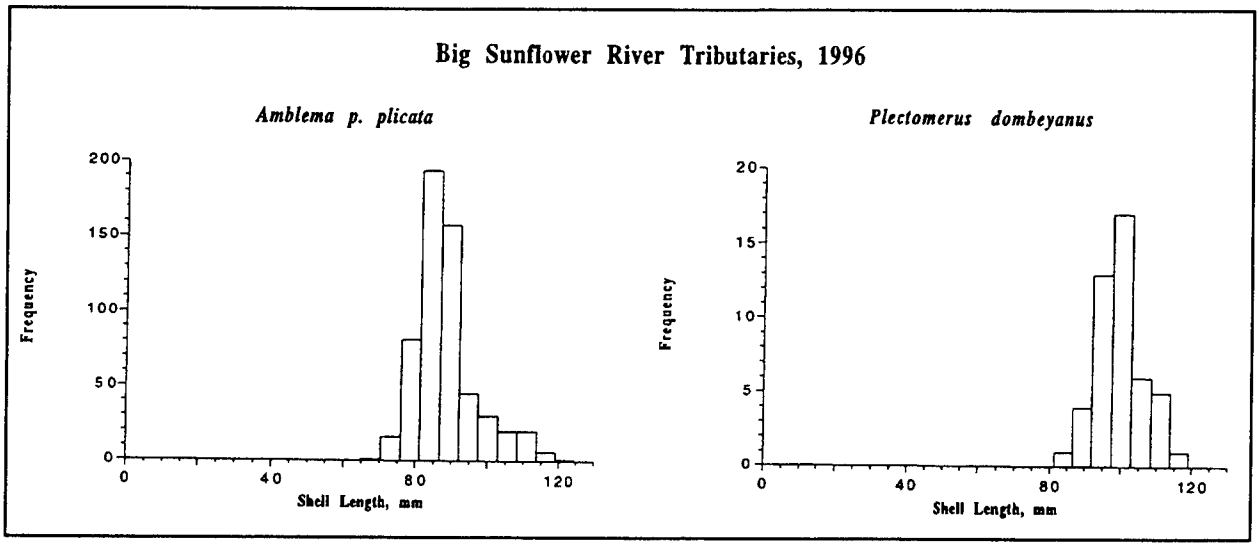

Figure 8. Size demography of dominant mussel species in project area

commercially is *A. p. plicata*. *Plectomerus dombeyanus* is moderately abundant although not marketable.

In February 1994, the Mississippi Department of Wildlife, Fisheries and Parks tentatively established minimum sizes for marketable shells in the Big Sunflower River. The minimum marketable size of *A. p. plicata* was set at 2 5/8 in. (66.7 mm) high. For mussels collected during this survey, shell length was converted to shell height (SH) by the following relationship taken from Miller and Payne (1995): SL = 0.57 * SH + 12.46 (r = 0.86). Based on this relationship, all *A. p. plicata* greater than 95 mm (3.7 in.) long should be marketable (Table 6).

Table 6
Maximum and Minimum Shell Lengths of all *Amblema p. plicata* Collected From Tributaries in Big Sunflower River Drainage, 1996

Parameter	Value
Total Number Analyzed	572
Min SL	67.3
Max SL	119.3
Range	51.9
Min marketable SL	95
Percent of the population > minimum marketable SL	15.9

Approximately 16 percent of all *A. p. plicata* were greater than 66.67 mm SH and are marketable. Average mass of all *A. p. plicata* greater than 66.67 mm high (SL = 95 mm) was 168.07 g. Based upon information provided by the Mississippi

Department of Wildlife, Fisheries and Parks, the price per pound (total live weight of *A. p. plicata*) was estimated to be $1.00.

The majority of *A. p. plicata* (87.5 percent) taken during this survey were found in Snake Creek. Therefore, dredging impacts were considered only for this tributary. The total number of *A. p. plicata* in Snake Creek was estimated by assuming that the mean density of this species ($41/m^2$, which is 87.5 percent of the total density, 46.9) existed in two 1-m strips (one on each streambank) for a distance of 16 km (16,000 m). Therefore, a total of 1,312,000 mussels would be in the river ($41/m^2 \times 1$ m of streambank $\times$ 2 banks $\times$ a distance of 16,000 m). Since only 16 percent were marketable, a total of 209,920 *A. p. plicata* would weigh 35,281 kg (15,750 lb) and would be valued at $15,750.

The above estimate assumes that all 16 km of Snake Creek in the project area is suitable for mussels. In a recent study of the Quiver River and Bogue Phalia, it was assumed that 50 and 25 percent, respectively, were suitable for *A. p. plicata.* If such were the case, then considerably less habitat would be affected by dredging.

4 Discussion

Bivalve Community

Although occasional extreme high densities were found in Snake Creek (up to 300/m), overall the fauna in this water body can be described as poor with low species richness and diversity and no evidence of recent recruitment. Overall density was extremely low in Jones Bayou, Marsh Bayou, Porter Bayou, and Turkey Bayou. It is difficult to determine why mussels reached extremely high density in some reaches of Snake Creek, yet exhibit so little evidence of recent recruitment. Mussels are probably stressed by elevated temperatures in the summer, low-calcium-content water, and high-sediment deposition.

In comparison with the Sunflower River, these small tributaries supported fewer individuals and species. A total of 26 species of native mussels were collected in the Sunflower River (Miller and Payne 1995). Twenty-two species were found in the Quiver River and ten were collected in Bogue Phalia (Miller and Payne, in preparation). Only 14 species were found in the five tributaries. Eleven species were found in Snake Creek, and twelve were found in Porter Bayou; the other three bayous each had less than five species present.

The total value of *A. p. plicata* and *M. nervosa* in the Big Sunflower River was estimated at $2.7 million for 1994 (Miller and Payne 1995). This estimate included four beds with moderately high to very high densities. In addition, low-density assemblages (usually no more than 5-10 individuals/square meter) were found along virtually all 50 river miles in the project area. In Bogue Phalia and Quiver River, approximately 56 and 43 miles, respectively, would be potentially impacted by dredging. The commercial value of *A. p. plicata* and *M. nervosa* in those two water bodies was estimated at $915,216 (Miller and Payne, in preparation), considerably more than $15,750 estimated for Snake Creek.

Populations of unionids that show substantial evidence of recent recruitment typically include many individuals less than 30 mm long. For example, *A. p. plicata* in the upper Mississippi River show evidence of at least some recruitment in nearly all years (Miller and Payne 1996). Population size demography of those populations typically include mussels ranging from less than 10 mm to slightly greater than 100 mm. It is not unusual for over half of the population to be less than 60 mm long in the upper Mississippi River. Clearly, evidence of recent recruitment is

drastically different in the Big Sunflower River drainage tributaries. With no *A. p. plicata* less than 65 mm long included among over 1,600 individuals collected, it is unequivocally evident that no successful recruitment is occurring.

Impacts of Dredging

Freshwater mussels would not survive being picked up by a dredge and transported to an upland disposal site. Limited survival could occur if dredged material was instead disposed in shallow water. Many species of mussels can extricate themselves after being buried, as long as sediments are not more than a few centimeters deep. Since only the center portion of a channel is usually dredged, mussels along the banks might not be disturbed. These mussels could be negatively affected by elevated suspended solids immediately downriver of an operating dredge. However, the molluscan gill and feeding palps are designed to separate nutritious particles from inorganic particles without food value, and mussels in the project area have adapted to a naturally high-suspended sediment regimen. There are many unknowns when attempting to predict impacts to mussels from dredging. The conservative approach, especially in small water bodies such as Snake Creek, would be to assume that virtually all mussels along the banks adjacent to dredged channels would be lost.

Concluding Comments

Negative effects of dredging would be noticed mainly in Snake Creek where high-density populations exist. Impacts to mussels in the other tributaries would be minor. Dredging impacts in Snake Creek could be minimized by avoiding certain high-density areas. In addition, the dredge cut should be as narrow and as deep as possible to avoid higher density areas along the riverbanks. However, the absence of recent recruitment in the project area, coupled with the low species richness and diversity, make this fauna particularly vulnerable to dredging impacts. Since recruitment is uncommon in these water bodies, dredged areas will not readily recolonize with mussels.

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Appendix A
Results of Qualitative Sampling for Freshwater Mussels in Five Tributaries of the Big Sunflower River Drainage, Mississippi, 1996

Table A1
Results of Qualitative Sampling for Freshwater Mussels in Jones Bayou, a Tributary of the Sunflower River, Mississippi, 1996

Species	Date											Total Mussels		Total Sites	
	31 May	31 May	31 May	31 May	13 Jun	13 Jun	13 Jun	13 Jun	13 Jun	13 Jun	13 Jun				
	Site 16	Site 17	Site 19	Site 18	Site 28	Site 27	Site 29a	Site 31	Site 30	Site 33	Site 32	Number	Percent	Number	Percent
A. p. plicata				1			1			66	67	135	93.75	4	36.36
Q. p. pustulosa											7	7	4.86	1	9.09
U. declivus									1			1	0.69	1	9.09
T. truncata										1		1	0.69	1	9.09
Total mussels	0	0	0	1	0	0	1	0	1	67	74	144			
Total species	0	0	0	1	0	0	1	0	1	2	2	4			
Total time, min	30	30	30	30	30	30	30	30	30	30	30	330			
Mussels/min	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.03	2.23	2.47	0.44			

Table A2
Results of Qualitative Sampling for Freshwater Mussels in Marsh Bayou, a Tributary of the Quiver River, Mississippi, 1996

Species	Date						Total Mussels		Total Sites	
	23 Jul	23 Jul	23 Jul	23 Jul	23 Jul	23 Jul				
	Site 40	Site 41	Site 42	Site 43	Site 44	Site 45	Number	Percent	Number	Percent
L. subrostrata			6				6	75.00	1	16.67
Q. quadrula			1				1	12.50	1	16.67
P. grandis			1				1	12.50	1	16.67
Total mussels	0	0	8	0	0	0	8			
Total species	0	0	3	0	0	0	3			
Total time, min	30	30	30	20	20	20	150			
Mussels/min	0.00	0.00	0.27	0.00	0.00	0.00	0.05			

Table A3
Results of Qualitative Sampling for Freshwater Mussels in Porter Bayou, a Tributary of the Sunflower River, Mississippi, 1996

Species	Date									Total Mussels		Total Sites	
	31 May Site 9	31 May Site 8	31 May Site 10	31 May Site 11a	24 May Site 11b	31 May Site 14	31 May Site 15	31 May Site 12	31 May Site 13	Number	Percent	Number	Percent
A. p. plicata	24	4	10	8	12		2			60	63.83	6	66.67
P. grandis				3	8	1	1			13	13.83	4	44.44
P. purpuratus	2	1	1							4	4.26	3	33.33
G. rotundata			3							3	3.11	1	11.11
P. dombeyanus					1			1	1	3	3.19	3	33.33
Q. nodulata			2							2	2.13	1	11.11
Q. p. pustulosa	1			1						2	2.13	2	22.22
A. suborbiculata				2						2	2.13	1	11.11
L. fragilis					2					2	2.13	1	11.11
P. alatus			1							1	1.06	1	11.11
L. teres								1		1	1.06	1	11.11
U. tetralasmus							1			1	1.06	1	11.11
Total mussels	27	5	17	14	23	1	4	2	1	94	Total		
Total species	3	2	5	4	4	1	3	2	1	12	Sites	9	
Total time	30	30	30	30	30	30	30	30	30	270			
Mussels/min	0.90	0.17	0.57	0.47	0.77	0.03	0.13	0.07	0.03	0.35			

Table A4
Results of Qualitative Sampling for Freshwater Mussels in Snake Creek, a Tributary of Bogue Phalia, Mississippi, 1996

Species	Date							
	24 May	30 May	30 May	30 May	30 May	30 May	30 May	12 Jun
	Site 46	Site 2	Site 1	Site 4	Site 3	Site 7	Site 6	Site 21
A. p. plicata	12	122	160	250	258	43	82	46
P. dombeyanus	6	12	5	8	12		4	1
P. grandis						1		
P. purpuratus	1	6	2	1				
L. teres	3					1	2	1
Q. p. pustulosa								
L. fragilis	5							
A. confragosus								
F. flava	1	1	1		1			
L. straminea	2							
A. ligamentina							1	
Total mussels	30	141	168	259	271	45	89	48
Total species	7	4	4	3	3	3	4	3
Total time, min	15	30	30	30	30	30	30	30
Mussels/min	2.00	4.70	5.60	8.63	9.03	1.50	2.97	1.60

(Continued)

Table A4 (Concluded)

Species	Date								Total Mussels		Total Sites	
	12 Jun	12 Jun	30 May	30 May	12 Jun	12 Jun	12 Jun	12 Jun				
	Site 20	Site 22	Site 5a	Site 5b	Site 24	Site 23	Site 26	Site 25	Number	Percent	Number	Percent
A. p. plicata	13	37	99	33	107	58	22	83	1,425	92.65	16	100.00
P. dombeyanus					1	22			71	4.62	9	56.25
P. grandis			2						3	0.20	2	12.50
P. purpuratus									10	0.65	4	25.00
L. teres	1	1		1	1	1		1	13	0.85	10	62.50
Q. p. pustulosa					1				1	0.07	1	6.25
L. fragilis						1			6	0.39	2	12.50
A. confragosus		1			1				2	0.13	2	12.50
F. flava									4	0.26	4	25.00
L. straminea									2	0.13	1	6.25
A. ligamentina									1	0.07	1	6.25
Total mussels	14	39	101	34	111	82	22	84	1,538	Total		
Total species	2	3	2	2	5	4	1	2	11	Sites	16	
Total time	30	30	30	30	30	30	30	30	465			
Mussels/min	0.47	1.30	3.37	1.13	3.70	2.73	0.73	2.80	3.31			

Table A5
Results of Qualitative Sampling for Freshwater Mussels in Turkey Bayou, a Tributary of the Quiver River, Mississippi, 1996

Species	Date						Total Mussels		Total Sites	
	13 June	13 June	13 June	13 June	13 June	13 June				
	Site 37	Site 36	Site 39	Site 38	Site 35	Site 34	Number	Percent	Number	Percent
A. p. plicata	1	6				1	8	57.14	3	50.00
L. fragilis	1	2					3	21.43	2	33.33
P. dombeyanus	2						2	14.29	1	16.67
P. purpuratus		1					1	7.14	1	16.67
Total mussels	4	9	0	0	0	1	14			
Total species	3	3	0	0	0	1	4			
Total time, min	30	30	30	30	7.5	7.5	135			
Mussels/min	0.13	0.30	0.00	0.00	0.00	0.13	0.10			

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13. ABSTRACT *(Maximum 200 words)*

A survey to assess community characteristics, density, population demography of dominant species, and the presence of endangered species of mussels (Family: Unionidae) was conducted in five tributaries in the Sunflower River Drainage, northwestern Mississippi in 1996. Tributaries were Jones Bayou, Marsh Bayou, Porter Bayou, Snake Creek, and Turkey Bayou located in Bolivar, Leflore, and Sunflower counties. Work was done for the U.S. Army Engineer District, Vicksburg, and results will be used to determine environmental effects of maintenance dredging proposed for selected reaches of these tributaries.

A total of 1,798 live mussels and 20 species were collected during 1,350 min of search time at 48 sites in the study area. The fauna was heavily dominated by *Amblema plicata plicata*, which made up 91 percent of the collection. Species diversity and evenness, 0.54 and 0.33, were low. No evidence of recent recruitment (individuals less than 30-mm total shell length) was found. No uncommon, threatened, or endangered species were collected. The zebra mussel, *Dreissena polymorpha*, was not seen. The molluscan fauna in these tributaries is stressed, probably by high temperatures, low dissolved oxygen, and low current velocity.

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Approximately 85 percent of the qualitative mussel collection came from Snake Creek; total mean density along this water body was estimated at 46.9 individuals/square meter. At Marsh Bayou, Porter Bayou, and Turkey Bayou, total mean density was either 0 or less than 1.0/square meter. At Jones Bayou, total mean density was estimated at 4.8 individuals/square meter. The commercial value of *A. p. plicata* in Snake Creek was estimated at $15,750.

Maintenance dredging will negatively affect mussels in Snake Creek. The lack of recent recruitment, dominance of a single species, and low species richness make this fauna vulnerable. Only minor impacts would occur in the other tributaries since mussel densities are extremely low.